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Brazilian Peach (*Prunus Persica*) and Passion Fruit (*Passiflora Edulis*) Nectars: Good Source of Vitamin C and Anthocyanins?

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Abstract

Peach and passion fruit nectars are well accepted by consumers and promise important sources of bioactive compounds. In this study it was analyzed vitamin C; anthocyanins; pH; total soluble solids; titratable acidity; total carbohydrates and *Ratio* (*Ratio* of total solids to citric acid) in different brands of peach and passion fruit nectar and results were compared to the Brazilian Legislation. Values of Vitamin C, anthocyanins, pH, soluble solids, titratable acidity, and total carbohydrates were analyzed. Results showed many variations in acidity, total soluble solids, carbohydrates and *Ratio* of nectars of the different brands. Peach and passion fruit nectars marketed in Brazil are good alternatives of ingesting vitamin C as all brands have more than 30% of the recommended daily intake, however, most brands possesses values much higher than stated on the labeling. For anthocyanins values, although there are patterns in Brazilian law, it can be seen from the results that there is great variation between the brands and some have very low values, indicating that the incorporation of this parameter on the labeling would be important once more aware and concerned consumers could choose the brand they thought most appropriate for their need. In conclusion it is possible to say the peach and passion fruit nectars marketed in Brazil are good alternatives of ingesting vitamin C as all brands have more than 30% of the recommended daily intake indicating they are considered "rich in vitamin C". Although, in the other hand, brands of both flavors are found in amounts higher than stated on the labeling. Values of soluble solids, acidity in citric acid and total carbohydrates are according Brazilian Legislation. Values of *Ratio* indicate that the nectars analyzed are adequate according to acceptability parameters.

Keywords: passion fruit, peach, nectar, Vitamin C, Anthocyanin

1. Introduction

The Brazilian market for juices and nectars ready to drink is expanding, following the worldwide trend of consumption of healthy, convenient and tasty beverages. The current demand for these products is due to changes in lifestyle of the population and the search for foods that have quality and practicality (Carneiro et al., 2013; Shinagawa et al., 2013).

Data from the Brazilian Association of Soft Drinks and Non-alcoholic Beverages Industries (ABIR) show that the nectar sales grew significantly during the last 4 years with the participation of 3.6% of the beverage market, behind only of the soft drinks that still are the most consumed (ABIR, 2015).

Unlike juice, nectar has a lower content of pure juice that can vary from 25% to 99% and may contain sweeteners, dyes and preservatives, additives that are usually cheaper than the soluble solids of the fruit, which makes it more affordable than the juice (Venancio & Martins, 2012). Similar definitions for nectars are found in Food and Drug Regulations - Canada (2015) and in Codex General Standard for Fruit Juices and Nectars (2005).

The passion fruit and peach juices and nectars are highly appreciated by the population for its pleasant flavor. Peach, (*Prunus persica* (L) Batsch) has significant socio-economic importance to the southern region of Brazil and its production is intended for consumption in fresh form and processed drinks (Senantin, Rodriguez-Amaya,

2007). The yellow passion fruit (*Passiflora edulis* Sims f. *flavicarpa* Deg) juice and nectar consumption is increasing rapidly by the Brazilian consumers representing approximately 8.5% of the volume of juices or nectars ready to drink that are sold in the country (Santos et al., 2013; Pimentel et al., 2009; Meletti, 2011).

Ascorbic acid is an essential vitamin in humans and may exhibit antioxidant and anti-inflammatory activity (Miles et al., 2015; Li et al., 2015; Sato et al., 2015). Anthocyanins are phenolic compounds considered best-known natural red colorant used in foods, and also have several significant biological effects such as antioxidant, anti-inflammatory and vasodilation. Antioxidant and anti-inflammatory activity are related to the prevention of inflammation disorders, diabetes, obesity, metabolic syndrome, cardiovascular diseases, or have protective effects to lower the risk of many kinds of cancer (Skrovankova et al., 2015; Min et al., 2015). These compounds are of great interest food technologists and nutritionists due to the opportunity to use them as functional foods components. Functional foods have become very popular due to the consumer demands for healthier products that could prevent risk of many diseases and improve health conditions (Kirca, Ozkan & Cemerogly, 2005; Skrovankova et al., 2015). Peach and passion fruit may contain ascorbic acid and anthocyanins and the nectar of these fruits can be easy alternatives of consumption.

The objective of this study was to analyze different brands of peach and passion fruit nectars, according to the parameters of vitamin C; anthocyanins; pH; total soluble solids; titratable acidity; total carbohydrates and *Ratio*, compare the results with the Brazilian Identity and Quality Standards and the Labeling and observe if they are good sources of Vitamin C and anthocyanins.

2. Methods

2.1Materials and Analyses

The passion fruit and peach nectars studied were purchased from local businesses (Marília city, São Paulo – Brazil) between May and June 2015. Five widely consumed brands were selected for peach nectar, which are designated as A (version *kids*), B (version *premium*), C, D and E. For passion fruit nectars we selected 4 brands: A, A version *kids* (that is also *brand A* but in another commercialized version called "Kids"), C, D and E. All the analyses were performed in triplicate (one sample of the brand was collected and analyzed in triplicate). The temperature at the determination time was 25^0C.

Values of Vitamin C were expressed as mg/100mL of nectar, and were determined according to Terada et al. (1978).

Values of Anthocyanins were expressed as mg/100g, and were analyzed according to Lees & Francis (1972).

Analysis of pH, total soluble solids, titratable acidity, and total carbohydrates were performed in triplicate according to Adolfo Lutz Institute (2008).

The pH levels were obtained using a digital pH meter with automatic temperature compensation. Total soluble solids, expressed in ºBrix, were determined from readings taken with an Abbe refractometer. The total carbohydrates content were expressed in % (m/m), and titratable acidity, expressed as % (v/v) of citric acid.

The *Ratio* was calculated based on the *Ratio* of total solids (ºBrix) and acidity in citric acid.

2.2 Statistical Analysis

The average values of vitamin C (mg/100mL), anthocyanins (mg/100g), pH, ºBrix, acidity (% v/v), total carbohydrates (% m/m) and *Ratio* were compared by analysis of variance (One-Way ANOVA), complemented with Tukey's test (independent samples) and Student's *t* test and level of significance used was $P = .05$.

3. Results and Discussion

Table 1 shows the results of the physicochemical analysis of the five peach nectar brands expressed as mean and standard deviation with respect to the parameters of vitamin C, anthocyanins, pH, Brix, acidity of citric acid, total carbohydrates and *Ratio*. The same parameters are found in Table 2 for the passion fruit nectar.

Table 1. Values of Vitamin C, Anthocyanins and other physicochemical parameters of peach nectars (brands A, B, C, D and E)*

Parameters	Peach nectar brands				
	A *Kids*	**B**	**C**	**D**	**E**
Vitamin C (mg/100mL)	63.40 ± 5.63 b(1)	33.53 ± 1.56 a	76.87 ± 2.16 b	34.33 ± 0.76 a	38.77 ± 2.78 a
Anthocyanins (mg/100g)	0.72 ± 0.48 a	0.17 ± 0.17 a	0.28 ± 0.09 a	6.62 ± 1.50 b	1.78±0.26 a
pH	3.28 ± 0.12 a	3.29± 0.11 a	3.01± 0.32 a	3.31± 0.13 a	3.62± 0. 22 a
°Brix[2]	11.03 ± 0.31 a	12.50 ± 0.17 b	14.20 ± 0.17 c	14.13 ± 0.15 c	12.20± 0.00 b
Acidity (% v/v) (g/100g)	0.33±0.01 c	0.32±0.00 b	0.37±0.00 e	0.34±0.00 d	0.28±0.00 a
Total carboydrates (% m/m)	7.91 ± 0.16 b	8.50 ± 0.40 b	10.24±0.13 c	10.55±0.57 c	6.51±0.3 a
Ratio[3]	33.77±0.42 a	39.06±0.54 c	38.38±0.47 b	41.57±0.45 c	44.11±0.93 d

[1]Means followed by at least one same letter do not statistically differ. [2]Total soluble solid content. [3]*Ratio* of total solids (ºBrix) to acidity in citric acid.

Values are means and standard deviation of the three determinations. Analysis of variance (ANOVA), complemented with Tukey's test and Student's t test and level of significance used was P = .05.

Table 2. Values of Vitamin C, Anthocyanins and other physicochemical parameters of passion fruit nectar (brands A, A *kids*, C, D and E)*

Parameters	Passion fruit nectar brands				
	A	**A(*kids*)**	**C**	**D**	**E**
Vitamin C (mg/100m)	20.990± 4.120 c(1)	65.60 ± 1.150 b	36.20 ± 1.97 a	29.90 ± 2.65 a	30.70±0.82 a
Anthocyanins (mg/100g)	3.617 ± 1.111 b	0.943 ± 0.510 a	1.393 ± 0.092 a	1.110 ± 0.348 a	1.283 ± 0.098 a
pH	3.18 ± 0.27 a	3.13 ± 0.08 a	3.01 ± 0.19 a[1]	3.04 ± 0.24 a	2.69 ± 0.08 a
°Brix[2]	12.70± 0.46 b	11.47 ± 0.72 a	11.53 ± 0.31 a	13.73 ± 0.21 b	13.27 ± 0.15 b
Acidity (% v/v) (g/100g)	0.51±0.11 c	0.44±0.02 a	0.47±0.00 B	0.53±0.00 c	0.47±0.00 b
Total carboydrates (% m/m)	8.80 ± 0.20 b	7.39 ± 0.22 a	7.80 ± 0.05 a	10.10 ± 0.07 d	9.83 ± 0.35 c
Ratio[3]	24.74±0.89 a	26.32±2.58 ab	24.54±0.65 a	25.91±0.39 ab	28.23±0.33 b

[1]Means followed by at least one same letter do not statistically differ. [2]Total soluble solid content. [3]*Ratio* of total solids (ºBrix) acidity in citric acid.

Values are means and standard deviation of the three determinations. Analysis of variance (ANOVA), complemented with Tukey's test and Student's t test and level of significance used was P = .05.

With regard to vitamin C (L-ascorbic acid), the results for the peach nectar showed no significant differences between the brands A and C, as there was no difference between B, D and E. Results for nectar of the brand A and B, are four times higher than the amount stated on the packaging. In the brand C, the vitamin content found was five times higher than mentioned in the nutritional information on the labeling. For brands D and E, there are not values declared on the nutrition label of the package for this vitamin. These results are much higher than those found by Toralles et al., 2006; Jacometti, Meneguel & Yamashita, 2003. The passion fruit nectars exhibit significant differences in vitamin C values for the brands A and A kids, and it was observed that these 2 types was increased up to 191.5% in the amount of vitamin C than that indicated on the label.

Vitamin C is considered an important quality parameter, not only because of its nutritional value but also because of its functional contributions to product quality. When compared to other nutrients, vitamin C is more vulnerable to degradation during processing steps and storage, so it can be used as an indicator of the nutritional quality of products derived from fruits and vegetables. The processing conditions may reduce the content of vitamin C significantly when associated with the type of packaging, the presence of oxygen and especially the storage conditions (Venancio & Martins, 2012; Chin, Zambiazi & Rodrigues, 2013). The Brazilian Legislation does not establish standards for vitamin C values for peach and passion fruit nectars. The Resolution Number 54 of 12 November 2012 states that food can be declared rich in vitamin, if it meets at least 30% of the Recommended Daily Intake (RDI), which in the case of vitamin C is 45 mg for an adult. To be considered a source of some vitamin, it must meet at least 15% of the RDI reference per serving. For this query, peach and passion fruit nectars are in accordance with the law because the amounts found are above 30% of the RDI. Besides they can be considerate rich or possessing high content of this vitamin (Brasil, 2012).

A possible explanation for the excess of vitamin C found in the nectar is the addition of this vitamin. Many beverages industries use ascorbic acid as a preservative and add it in large amounts to compensate for losses in the process and for color appearance and color stability (Cunha et al., 2014). Acidification of the nectar can be an alternative to minimize the loss of vitamin C, and the use of ascorbic acid as a food additive for preventing food spoilage by oxidative mechanisms is permitted by Brazilian Legislation (Brasil, 2010).

Vitamin C is associated to production of collagen, noradrenalin and serotonin, and steroid hormones. It is also a reducer agent, may modulate the immunity system and act as an antioxidant. Due to these attributes, Vitamin C is related with the prevention of innumerous diseases (Freitas et al., 2015; Rutkowsku & Grzegorczyk, 2012). By the other hand, high doses of synthetic Vitamin C, instead of expected health benefits, may lead to hypervitaminosis and even to intoxication. In addition, it is possible the occurrence of interactions of Vitamin C with concomitantly used drugs, as well as intensification of side effects promoted by various exogenous chemical factors. This vitamin is practically nontoxic but doses of 500 mg/d or more may cause erythrocyte hemolysis, nausea, destruction of β-pancreatic cells, and diarrhea. Higher doses (> 1g/day) increase the risk of calculi formation from calcium oxalate. Ascorbic acid may also exhibit pro-oxidant due to the transition ion metal-reducing abilities of the vitamin. Larger doses may lead to tolerance and dependency (Ruskowski & Grzegorczyk, 2012; Halliwell, 1999; Taylor, Stamper, & Curhan, 2004). After analyzing these facts, it is important to suggest caution in the consumption of high volumes of nectars with high doses of Vitamin C.

Results for anthocyanins show higher values (3.61±1.11) for brand D in peach nectar and higher values (6.62±1.15) in brand A for passion fruit nectar (Table 1 and 2). This parameter is of fundamental importance to health but still lacks quality and identity parameters established by Brazilian Legislation. Anthocyanins are unstable pigments and can be degraded during processing steps and storage. Besides temperature, other factors including pH and oxygen also affect the stability of these pigments (Novello, 2011; Parzonko & Naruszewicz, 2015; Mullero et al., 2015). As anthocyanins are phytochemicals, there is no statement of recommended doses. Kirca et al. (2005) found anthocyanin values of 3.77mg/mL for peach nectars. Kuskoski et al. (2006) did not find these components in passion fruit frozen pulp.

The results obtained in the pH analysis showed no statistically significant differences among the five brands of peach and passion fruit nectar (Tables 1 and 2). This parameter is not regulated by the Brazilian Legislation to the peach and passion fruit nectar, but it is of fundamental importance for the beverage formulation, since values higher than 4.5 favor the growth of *Clostridium botulinum*. All the samples studied in this work presented pH below this value. Castro et al. (2007) showed that pH is an important parameter to be evaluated as it influences mainly the presence of anthocyanins. Miranda (2015) and DiLucio (2010) studied the variation in pH peach juice from different cultivars and obtained similar values to our work.

The total soluble solids analysis is used as quality index and maturity of some fruits, because they indicate the amount of substances that are dissolved in the juice, being mostly sugars (Shinagawa et al, 2013). As seen in

Table 1, the results for total soluble solids show variations between different peach nectar brands with variations from 11.03 to 14.20 °Brix. For passion fruit nectar, the brands A, D and E do not differ, as well as C brand is not different from the *kids* version. All brands studied are in accordance with Brazilian law for this parameter (Brasil, 2003). Our results for peach nectar Brix are similar to those obtained by Di Luccio (2010) and Sainz (2006). For passion fruit nectar our results are similar to Felipe et al. (2006). Similar Brix Level for passion fruit and peach juice were found in the *Codex Alimentarius* - Codex General Standard for fruit juices and nectars (2005).

For results of acidity in citric acid we did not find significant variation among the brands of both flavors, and the values are in accordance with Brazilian Legislation (Brasil, 2003). Our results for passion fruit nectar were higher than reported by Miranda et al. (2015). Souza (2009) and Sainz (2006) obtained higher values than those presented in this paper for the peach nectar. Gomes et al (2006) found similar acidity values for passion fruit pulp when comparing to our results, however Raimundo et al. (2009) obtained much lower values. The acidity analysis is a food storage display for the reactions involved in the decomposition and hydrolysis, oxidation and fermentation generates acid compounds which increase the acidity (Chim, Zambiazi, & Rodrigues, 2013).

The total carbohydrates values showed significant differences between the brands (Tables 1 and 2), with variations of 6.51% to 10.35% m/m for the peach nectars and 7.39 ± 0.22 to 10.10 ± 0.07 to passion fruit nectars. Peach nectar brand E is not in agreement with the Brazilian Legislation standards of identity and quality that requires a minimum of 7.00g/100g for this parameter. Souza (2009) found values higher than this study to peach nectar with the exception of brands D and C. For the passion fruit nectar, brand D shows much significant difference when compared to the others but they are in accordance to the Brazilian Legislation.

Figueira et al. (2010) postulated that the *Ratio* is an important indicator for the production of citrus juice industry and consumers of citrus juices prefer products with *Ratio* ranging from 15 to 18. Values for peach nectars values ranged from 33.77 to 44.11 in the different brands. For passion fruit nectar, variation was observed from 24.54 to 28.23. Sainz (2006) showed *Ratio* much lower to peach juice when comparing to our results. Raimundo et al (2009) and Gomes et al. (2006) found higher values to passion fruit pulp. Di Luccio (2010) showed that changes in the *Ratio* can be associated to the management and the degree of ripeness of the fruit. Studies indicate that in the United States and Europe the main acceptability parameter in juices is given by the *Ratio* of total soluble solids and titratable acidity. Thus values higher than 15.0 are considered ideal for fruit beverages (Sainz, 2006).

The identity and quality parameters are extremely important for the production of nectars and our results show that Brazilian industries need to adjust a few parameters.

4. Conclusion

The peach and passion fruit nectars marketed in Brazil are good alternatives of ingesting vitamin C as all brands have more than 30% of the recommended daily intake indicating they are considered “rich in vitamin C”. By the other hand, brands of both flavors are found in amounts higher than stated on the labeling.

For anthocyanins values, although there are no patterns in Brazilian law, it can be seen from the results that there is great variation between the brands and some have very low values.

Values of soluble solids, acidity in citric acid and total carbohydrates are according Brazilian Legislation. Values of *Ratio* indicate that the nectars analyzed are adequate according to acceptability parameter.

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